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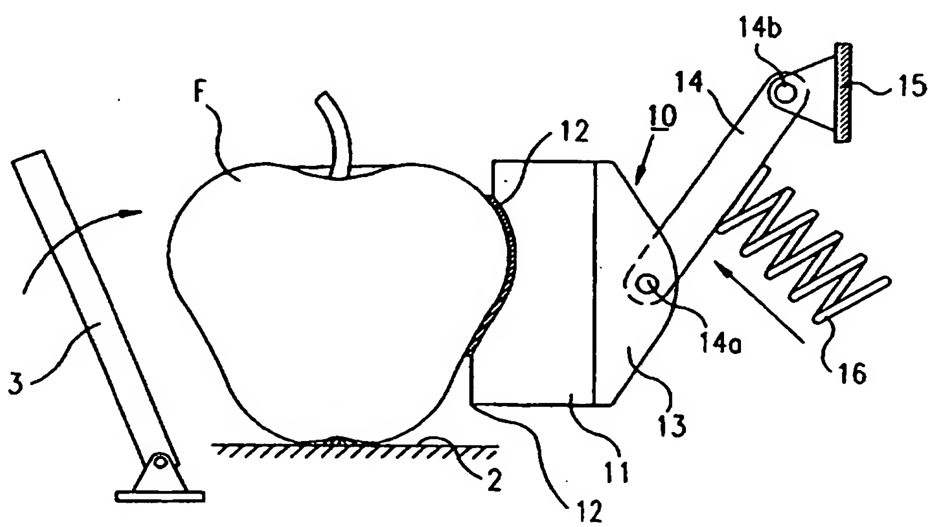

(57) Abstract

A method and apparatus for testing the quality of fruit by applying a dynamic force to the fruit, and detecting the mechanical response via a transducer which includes a resilient pad (11) carrying a piezoelectric film transducer (12), and a floating spring mounting (13, 14, 15, 16) for the resilient pad effective to yield when the piezoelectric film transducer (12) contacts a fruit to cause the piezoelectric film transducer (12) to engage and conform to the outer surface of the fruit. Also described are a method and apparatus for monitoring changes in the condition of fruit in a storage room by placing a sample of the fruit in a holder in the storage room, and at successive intervals remotely actuating a dynamic force applicator (3, 4, 5) in the storage room to output an electrical signal corresponding to the condition of the fruit sample within the storage room.

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TESTING AND MONITORING THE QUALITY OF FRUIT

The present invention relates to a method and apparatus for testing the quality of fruit. The invention also relates to a method and apparatus for monitoring changes in the condition of fruit, e.g., while in a storage room, such as its ripening progress, loss of water, ageing or other quality degradation of the fruit.

The term "fruit" is used herein in its broader aspect, as referring to a plant crop or product, to include not only conventional fruits, but also products normally called vegetables, such as tomatoes, potatoes, etc.

High-value fresh agricultural products, particularly those intended for export, must be carefully handled and sorted in order to meet high quality standards. Many methods are available for testing the quality of fruit and for sorting according to external fruit properties, such as size, shape, color and external appearance. Internal properties, such as ripeness, taste, flavor and internal damage, are generally determined indirectly, by linking the property to one or more external fruit properties, or are measured directly through destructive tests.

It is also known to test the quality of a fruit by applying a dynamic force to the fruit and detecting the mechanical response of the fruit to the dynamic force, as described for example in US Patents 2,277,037 and 5,152,401. In such devices, the mechanical response of the fruit to the dynamic force is generally detected by a conventional piezoelectric sensor which undergoes compressional strain to output an electrical signal. Such apparatus, however, has not found widespread use presumably because the electrical signal outputted by the conventional piezeoelectric sensor does not provide a satisfactory indication of the quality of the fruit.

A recent development, as described in International Publication No.WO/94/29715 (International

Application No.PCT/US94/06869), detects the mechanical response of the fruit to the dynamic force via a piezoelectric film transducer supported on a displaceable supporting member such that the film transducer is bent by the dynamic force to induce a strain in the film transducer. It has been found that the output signal produced as a result of such bending strains, as distinguished from compression strains in the conventional sensor, provides a more accurate measurement of the quality of the fruit being tested. However, even the output signal of such a sensor in the described apparatus is not sufficiently reliable to enable widespread use of this method.

An object of the present invention is to provide an improvement in the method and apparatus for testing the quality of fruit described in WO/94/29715. Another object of the invention is to provide a method and apparatus for monitoring changes in the condition of fruit, e.g., while in a storage room.

According to one aspect of the present invention, there is provided a method of testing the quality of fruit, comprising: applying a dynamic force to the fruit; detecting the mechanical response of the fruit to the dynamic force via a piezoelectric film transducer supported on a displaceable supporting member such that the film transducer is bent to induce a strain therein by the dynamic force and outputs an electrical signal corresponding to the induced strain in the film transducer caused by the dynamic force; and analyzing the electrical signal to indicate the quality of the fruit; characterized in that the displaceable supporting member includes: a resilient pad having an outer surface of relatively large surface area carrying, on its outer surface, the piezoelectric film transducer, which is also of relatively large surface area; and a floating spring mounting for the resilient pad effective to yield when the piezoelectric film transducer contacts a fruit to cause the piezoelectric film transducer to engage and conform to the

outer surface of fruit of a large range of sizes and shapes.

It has been found that such a method produces output signals which more accurately reflect the quality of the fruit under test, and which are less sensitive to differences in the outer contour and size of the fruit, as compared to the method described in WO/94/29715.

According to further features in the preferred embodiment of the invention described below, there are a plurality of the piezoelectric film transducers each supported on one of the displaceable supporting members at different locations around the circumference of the fruit to provide three such surface contacts with the fruit.

According to another aspect of the present invention, there is provided a method of monitoring changes in the condition of fruit in a storage room, comprising: placing a sample of the fruit in a holder in the storage room, which holder includes a dynamic force applicator for applying a dynamic force to the fruit sample, and a transducer which outputs an electrical signal corresponding to the mechanical response of the fruit sample to the dynamic force applied thereto; at successive intervals, remotely actuating the dynamic force applicator from a location externally of the storage room to output an electrical signal corresponding to the condition of the fruit sample within the storage room; feeding the output electrical signal to a location externally of the storage room; and analyzing the electrical signal externally of the storage room to indicate the condition of the fruit sample.

Such a method is particularly useful in storage rooms involving a controlled (e.g., cooled and/or gaseous) atmosphere since it enables the condition, e.g., ripening progress, of the fruit within the storage room to be continuously monitored without causing any interference with the controlled atmosphere which would result by entering and leaving the storage room in order to monitor the ripening progress of the fruit.

The invention also provides apparatus for practicing the invention in accordance with the above methods.

Further features and advantages of the invention will be apparent from the description below.

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

Fig. 1 is a side elevational view diagrammatically illustrating one form of apparatus constructed in accordance with the present invention;

Fig. 2 is a top plan view illustrating the apparatus of Fig. 1;

Fig. 3 is a side elevational view illustrating another form of apparatus constructed in accordance with the present invention;

Figs. 4 and 5 are side and plan views, respectively, illustrating a further form of apparatus constructed in accordance with the present invention;

Figs. 6 and 7 are side and plan views, respectively, illustrating a further form of apparatus constructed in accordance with the present invention;

Fig. 8 is a side elevational view illustrating a still further form of apparatus constructed in accordance with the present invention;

Fig. 9 diagrammatically illustrates a method of monitoring the ripening progress of fruit within a storage room in accordance with a further aspect of the present invention;

and Figs. 10, 11 and 12 illustrate three arrangements that may be used for holding and testing a fruit sample in the monitoring method of Fig. 9.

The apparatus illustrated in Figs. 1 and 2 includes a holder or bed, schematically indicated at 2, for receiving the fruit F, such as an apple, to be tested. The holder further includes dynamic force applying means for applying a dynamic force to the fruit F in holder 2, and

detector means for detecting the mechanical response of the fruit to such a dynamic force. In the example illustrated in Figs. 1 and 2, the dynamic force applying means includes three pivotally mounted levers 3, 4, 5, equallly spaced around the circumference of the fruit F and each pivotal to impact the fruit; and the mechanical response detectors are constituted by three detectors 8, 9, 10, also equally spaced around the circumference of the fruit for detecting the mechanical response of the fruit to the applied dynamic force.

The construction of each of the three detectors 8, 9, 10 is more particularly illustrated with respect to detector 10. It includes a resilient pad 11 having an outer surface of relatively large surface area carrying, on its outer surface, a piezoelectric film transducer 12 which is also of relatively large surface area. The opposite face of resilient pad 11 is fixed (e.g., by adhesive or a clamp) to a base member 13, which is pivotally mounted at its center at one end 14a of a lever 14. The opposite end 14b of lever 14 is pivotally mounted to a fixed supporting member 15. Lever 16 is urged by spring 16 towards holder 2 to bring the piezoelectric film transducer 12 into firm contact with the outer surface of the fruit F in the holder.

The piezoelectric film transducer 12, and also the resilient pad 11 on which it is mounted, may be of the structure as described in WO/94/29715, but is preferably of substantially larger surface area. Thus, the transducer may be of polyvinylidine flouride piezoelectric film coated on opposite sides with a conductive coating, such as silver; and the resilient pad 11 may be of a suitable elastomeric material, such as expanded natural or synthetic rubber, or expanded polyurethane.

It has been found that the mounting arrangement illustrated in Figs. 1 and 2, for mounting the resilient pad 11 and the piezoelectric film transducer 12 carried on its outer surface, produces an output signal which is less sensitive than the mounting arrangements in WO/94/29715 to

differences in shapes and sizes of the fruit F being tested. Thus, lever 14, including its pivotal mountings at its opposite ends and spring 16, provides a floating spring mounting for resilient pad 11 effective to yield, when the piezoelectric film transducer 12 contacts a fruit, to cause the piezoelectric film transducer to engage and conform to the outer surface of fruit of a large range of sizes and shapes. When using such a floating spring mounting, the electrical signals outputted by the piezoelectric film transducer 12 more accurately reflect the quality condition of the fruit being tested irrespective of the curvature or size of the fruit.

Fig. 3 illustrates a modification in the floating spring mounting for the base member 13 carrying the resilient pad 11 and the piezoelectric film transducer 12 on its outer face. In this case, the floating spring mounting includes a leaf spring 18 pivotally mounted at one end 18a to the base member 13, and at the opposite end 18b to the fixed supporting member 15. The base member 13, its resilient pad 11, and piezoelectric film transducer 12, are urged by the inherent elasticity of leaf spring 18 towards the fruit such as to cause the piezoelectric film transducer to engage and conform to the outer surface of fruit of a large range of sizes and shapes, thereby making the electrical signal outputted by the transducer less sensitive to fruit of different shapes and sizes.

Figs. 4 and 5 illustrate an arrangement similar to that of Figs. 1 and 2, except that there is only one impact element 3, which is located between two of the detectors 8-10. Thus, as shown particularly in Fig. 5, the three detectors 8-10 are not uniformly spaced around the circumference of the fruit F holder; rather, two detectors 8, 9 are located on one side of the fruit holder 2 equally spaced from the transverse axis TA of the holder, and the third detector 10 is located on the opposite side of the holder along the transverse axis TA. The impact element 3

is located between the two detectors 8, 9 on the transverse axis TA.

Figs. 6 and 7 illustrate a slightly different arrangement, also including an impact element 3 located on the transverse axis TA of the fruit holder 2. In the arrangement illustrated in Figs. 6 and 7, the mechanical response detector, generally designated 20, includes a resilient pad divided into two sections 21a, 21b each carrying on its outer face a piezoelectric film transducer 22a, 22b, and each being fixed, on its inner face, to a base member 23a, 23b. The two base members 23a, 23b are pivotally mounted to the opposite ends of a bridge 24, and the bridge is in turn pivotally mounted at its center to a mounting member 25. A coiled spring 26 interposed between mounting member 25 and a fixed element 27 produces, with the foregoing elements, a floating spring mounting effective to cause the two setions of the piezoelectric film transducers 22a, 22b to engage and conform to the outer surface of the fruit F on holder 2 irrespective of the size or shape of the fruit under test, thereby outputting an electrical signal which is relatively insensitive to the size or shape of the fruit under test.

In the arrangement illustrated in Figs. 6 and 7, the holder 2 on the opposite side of the fruit under test is preferably provided with static shoulders 28, 29, rather than detector elements corresponding to detector 20, for engaging the opposite side of the fruit under test. The static shoulders 28, 29 are equally spaced on opposite sides of the transverse axis TA, as in Figs. 4 and 5.

It will be appreciated that instead of using static shoulders 28, 29 on the opposite sides of the fruit under test, transducer detector elements corresponding to detector 20 could also be used for each of the static shoulders, corresponding to the arrangement illustrated in Figs. 4 and 5; alternatively, in the arrangement illustrated in Figs. 4 and 5, the transducer detectors 8 and 9 could be

replaced by static shoulders corresponding to members 28 and 29 in Figs. 6 and 7.

Fig. 8 illustrates a still further floating spring mounting, generally designated 30, for the resilient pad 31 and piezoelectric film transducer 32 urged into yielding contact with the fruit under test. In this arrangement, the resilient pad 31 is carried by a base member 33 which is urged towards the fruit under test by a pair of springs 34, 35 interposed between the opposite ends of the base member and an intermediate member 36. Member 36 is in turn urged towards the fruit under test by a spring 37 interposed between the center of member 36 and a fixed supporting member 38 of the fruit holder. The arrangement illustrated in Fig. 8 thus also provides a floating spring mounting for the piezoelectric film transducer 32, causing it to engage and conform to the outer surface of fruit of a large range of sizes and shapes.

Fig. 9 illustrates a system for monitoring the condition, e.g., the ripening progress (or water ageing, or other quality degradation) of fruit within a plurality of storage rooms 40a-40n. Each storage room 40a-40n includes a holder 41a-41n for receiving a sample of the fruit stored therein; a dynamic force applicator, schematically indicated at 42a-42n, for applying a dynamic force to the fruit sample in the respective holder; and a piezoelectric transducer 43a-43n to be engaged by the fruit in the holder for outputting an electrical signal corresponding to the response of the fruit sample to the dynamic force applied by the applicator. The applicators are all controlled from externally of the storage room by a control, generally designated 44. Such control, for example, may include a switching box that sequentially switches the applicators in the various storage rooms, and amplifiers which receive the outputs of the piezoelectric transducers 43a-43n in the storage rooms, and amplify these electrical signals before being inputted into a computer 45.

The computer analyzes the electrical output signals to indicate the quality, particularly the stage in the ripening process, of each of the fruit samples in the holders 41a-41n. This information is outputted to a monitor 46, a printer 47, and/or a database 48, for displaying, recording, and/or further processing of this information.

Figs. 10, 11 and 12 illustrate three examples of arrangements that may be used for holding and testing a fruit sample in the monitoring method of Fig. 9.

As shown in Fig. 10, the holder for the fruit sample F includes a resilient pad 50 receiving the fruit sample between it and the transducer 51. The resilient pad 50 is formed with an opening 52 in alignment with the transducer 51. The dynamic force applicator includes an impact member 53 movable within a barrel 54 and driven through opening 52 to impact the fruit sample F. The drive, in the arrangement illustrated in Fig. 10, is an electromagnet 55 having a plunger 56 aligned with the impact member 53 to drive it against the fruit with each energization of the electromagnet.

Fig. 11 illustrates an arrangement wherein the plunger 56 driven by the electromagnet 55 is coupled to a lever arm 67, having one end 67a pivotally mounted to a fixed support, with the opposite end 67b engageable with the impact member 53 for driving it through opening 52 of the resilient pad 50 to impact the fruit sample F.

Fig. 12 illustrates a further arrangement wherein the impact member 53 is driven through the opening 52 in the resilient pad 50 by a spring 60, which spring is periodically loaded and released by a rotating cam 61.

It will be appreciated that the arrangements illustrated in Figs. 10-12 are merely illustrative, and that many other arrangements could be used, for example one wherein the impact member is driven by an air pulse or a hydraulic pulse.

The transducer 51 in Figs. 10-12 is preferably the piezoelectric film transducer included in the earlier-described embodiments, but may be other type of transducer.

It will thus be seen that the storage rooms 40a-40n, which may involve a controlled atmosphere such as a cooled and/or gaseous atmosphere (a storage room having a gaseous atmosphere for accelerating or otherwise controlling the ripening process being sometimes called a ripening room), need not be opened in order to monitor the progress of the ripening of the fruit within the storage room, but rather the progress can be monitored from a remote location externally of the storage rooms. Such a system, therefore, is not only much more convenient to operate, but also does not involve disturbing the controlled atmosphere within the storage rooms which would otherwise occur each time one enters or leaves the storage room.

While the invention has been described with respect to several preferred embodiments, it will be appreciated that these are set forth merely for purposes of example, and that many other variations, modifications and applications of the invention may be made.

CLAIMS

1. A method of testing the quality of fruit, comprising:

applying a dynamic force to the fruit;

detecting the mechanical response of the fruit to said dynamic force via a piezoelectric film transducer supported on a displaceable supporting member such that the film transducer is bent to induce a strain therein by said dynamic force and outputs an electrical signal corresponding to the induced strain in the film transducer caused by said dynamic force;

and analyzing said electrical signal to indicate the quality of the fruit;

characterized in that said displaceable supporting member includes:

a resilient pad having an outer surface of relatively large surface area carrying, on its outer surface, the piezoelectric film transducer, which is also of relatively large surface area;

and a floating spring mounting for the resilient pad effective to yield when the piezoelectric film transducer contacts a fruit to cause the piezoelectric film transducer to engage and conform to the outer surface of fruit of a large range of sizes and shapes.

2. The method according to Claim 1, wherein said floating spring mounting includes a pivotal mounting on an axis through the center of the resilient pad.

3. The method according to Claim 2, wherein said floating spring mounting includes a lever having at one end said pivotal mounting on an axis through the center of the resilient pad, and at the opposite end another pivotal mounting to a supporting structure.

4. The method according to Claim 1, wherein said floating spring mounting includes a leaf spring pivotally mounted at one end on an axis through the center of the resilient pad and urged by its inherent elasticity towards the fruit.

5. The method according to Claim 1, wherein said resilient pad and said piezoelectric film transducer carried thereby are divided into two sections each pivotally mounted at its center to a bridge, which bridge is pivotally mounted at its center to said floating spring mounting.

6. The method according to Claim 1, wherein said floating spring mounting includes a first spring aligned with the central portion of the resilient pad and engaging the central portion of a pressure applicator member having two further springs aligned with, and between, the opposite ends of the pressure applicator member and the resilient pad.

7. The method according to any one of Claims 1-6, wherein there are a plurality of said piezoelectric film transducers each supported on one of said displaceable supporting members at different locations around the circumference of the fruit to provide three such surface contacts with the fruit.

8. The method according to any one of Claims 1-7, wherein said fruit is located in a fruit storage room, said dynamic force applying means is actuated from externally of the storage room, and said electrical signal outputted by the piezeoelectric film transducer is fed to the analyzer means externally of the storage room.

9. A method of monitoring changes in the condition of fruit in a storage room, comprising:

placing a sample of the fruit in a holder in the storage room, which holder includes a dynamic force applicator for applying a dynamic force to the fruit sample, and a transducer which outputs an electrical signal corresponding to the mechanical response of the fruit sample to the dynamic force applied thereto;

at successive intervals, remotely actuating said dynamic force applicator from a location externally of the storage room to output an electrical signal corresponding to the condition of the fruit sample within the storage room;

feeding said electrical signal to a location externally of the storage room;

and analyzing said electrical signal externally of the storage room to indicate the ripening stage of the fruit sample.

10. The method according to Claim 9, wherein said transducer is a piezoelectric film transducer supported on a displaceable supporting member such that the film transducer is bent, to induce a strain therein, by said dynamic force to output said electrical signal.

11. The method according to Claim 10, wherein said displaceable supporting member includes:

a resilient pad having an outer surface of relatively large surface area carrying, on its outer surface, the piezoelectric film transducer, which is also of relatively large surface area;

and a floating spring mounting for the resilient pad effective to yield when the piezoelectric film transducer contacts a fruit to cause the piezoelectric film transducer to engage and conform to the outer surface of fruit of a large range of sizes and shapes.

12. Apparatus for testing the quality of fruit, comprising:

a holder for receiving the fruit to be tested;

dynamic force applying means for applying a dynamic force to the fruit in said holder;

a piezoelectric film transducer supported on a displaceable member such that the film transducer is bent to induce a strain therein by said dynamic force and outputs an electrical signal corresponding to the induced strain in the film transducer caused by said dynamic force;

and analyzer means for analyzing said electrical signal outputted by the piezoelectric film transducer to indicate the quality of the fruit;

characterized in that said displaceable supporting member includes:

a resilient pad having an outer surface of relatively large surface area carrying, on its outer surface, the piezoelectric film transducer, which is also of relatively large surface area;

and a floating spring mounting for the resilient pad effective to yield when the piezoelectric film transducer contacts a fruit to cause the piezoelectric film transducer to engage and conform to the outer surface of fruit of a large range of sizes and shapes.

13. The apparatus according to Claim 12, wherein said floating spring mounting includes a pivotal mounting on an axis through the center of the resilient pad.

14. The apparatus according to Claim 13, wherein said floating spring mounting includes a lever having at one end said pivotal mounting on an axis through the center of the resilient pad, and at the opposite end another pivotal mounting to a supporting structure.

15. The apparatus according to Claim 12, wherein said floating spring mounting includes a leaf spring pivotally mounted at one end on an axis through the center of the resilient pad and urged by its inherent elasticity towards the fruit.

16. The apparatus according to Claim 12, wherein said resilient pad and said piezoelectric film transducer carried thereby are divided into two sections each pivotally mounted at its center to a bridge, which bridge is pivotally mounted at its center to said floating spring mounting.

17. The apparatus according to Claim 12, wherein said floating spring mounting includes a first spring aligned with the central portion of the resilient pad and engaging the central portion of a pressure applicator member having two further springs aligned with, and between, the opposite ends of the pressure applicator member and the resilient pad.

18. The apparatus according to any one of Claims 12-17, wherein there are three of said piezoelectric film transducers each supported on one of three of said

displaceable supporting members at different locations around the circumference of the fruit to provide three surface contacts with the fruit.

19. A system for monitoring changes in the condition of fruit within a storage room, comprising:

apparatus according to any one of Claims 12-18 located in said storage room;

means located externally of said storage room for actuating said force applicator;

and means located externally of said storage room for receiving the electrical signals outputted by said transducer.

20. A system for monitoring changes in the condition of fruit in a storage room, comprising:

a holder in said storage room for receiving a sample of the fruit stored therein;

a dynamic force applicator in said storage room for applying a dynamic force to the fruit sample in said holder;

a transducer in said storage room to be engaged by the fruit in said holder for outputting an electrical signal corresponding to the response of the fruit sample to said dynamic force;

control means externally of said storage room for actuating said force actuator;

and analyzer means externally of said storage room for receiving the electrical signals outputted by the transducer and for indicating the condition of the fruit sample in the holder.

21. The system according to Claim 20, wherein said transducer is a piezoelectric film transducer supported on a displaceable member such that the film transducer is bent, to induce a strain therein, by the dynamic force, and outputs an electrical signal corresponding to the induced strain.

22. The system according to Claim 23, wherein said displaceable supporting member includes:

a resilient pad having an outer surface of relatively large surface area carrying, on its outer surface, the piezoelectric film transducer, which is also of relatively large surface area;

and a floating spring mounting for the resilient pad effective to yield when the piezoelectric film transducer contacts a fruit to cause the piezoelectric film transducer to engage and conform to the outer surface of fruit of a large range of sizes and shapes.

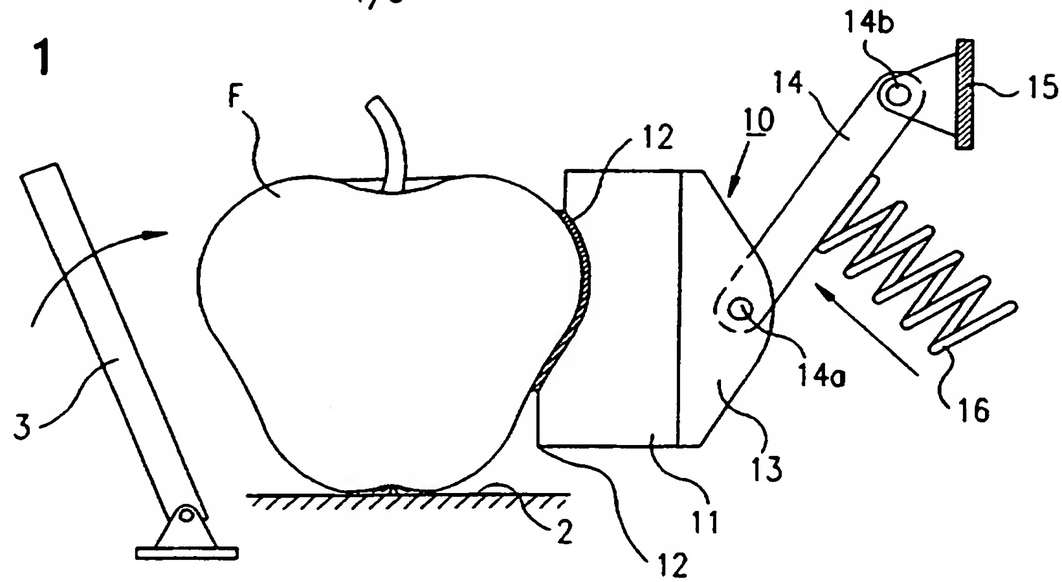
23. The system according to Claim 20, wherein said holder includes a resilient pad for receiving the fruit sample between it and said transducer, said resilient pad being formed with an opening therethrough; and wherein said dynamic force applicator includes an impact member and a drive for driving said impact member through said opening to impact the fruit sample.

24. The system according to Claim 23, wherein said drive is an electromagnet having a plunger aligned with said impact member.

25. The system according to Claim 23, wherein said drive is an electromagnet having a plunger driving a pivotal lever which drives said impact member.

26. The system according to Claim 23, wherein said drive is a spring which is loaded and released by the rotating cam.

FIG. 1



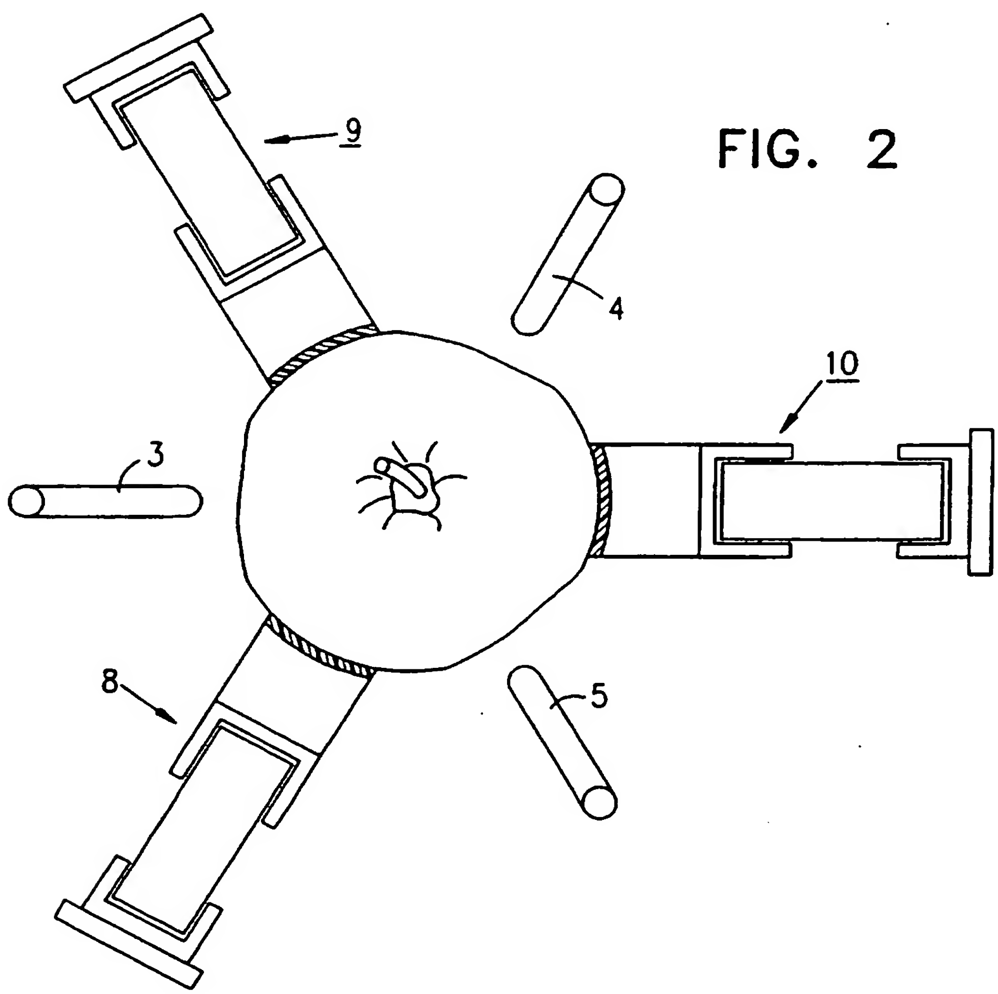
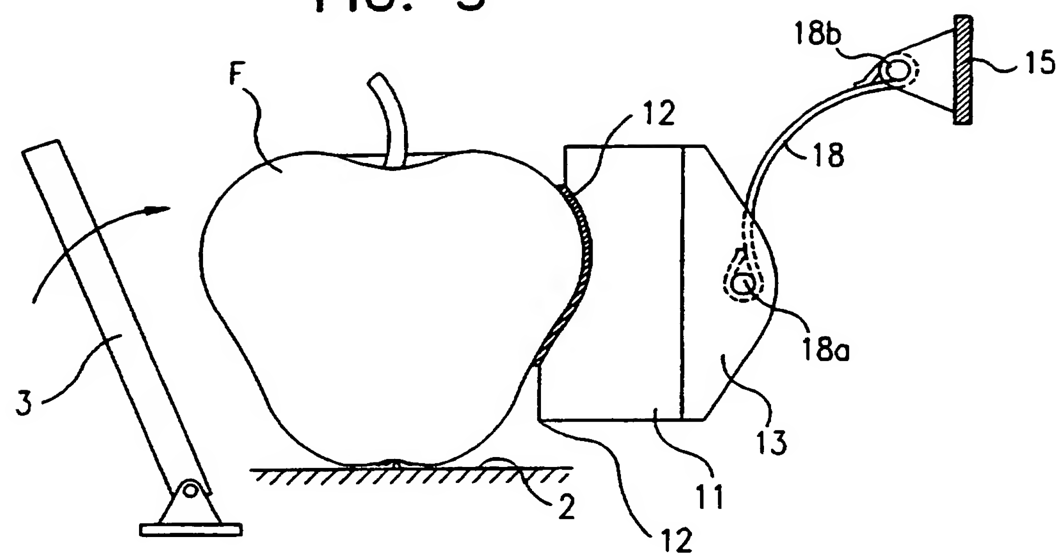


FIG. 2

FIG. 3



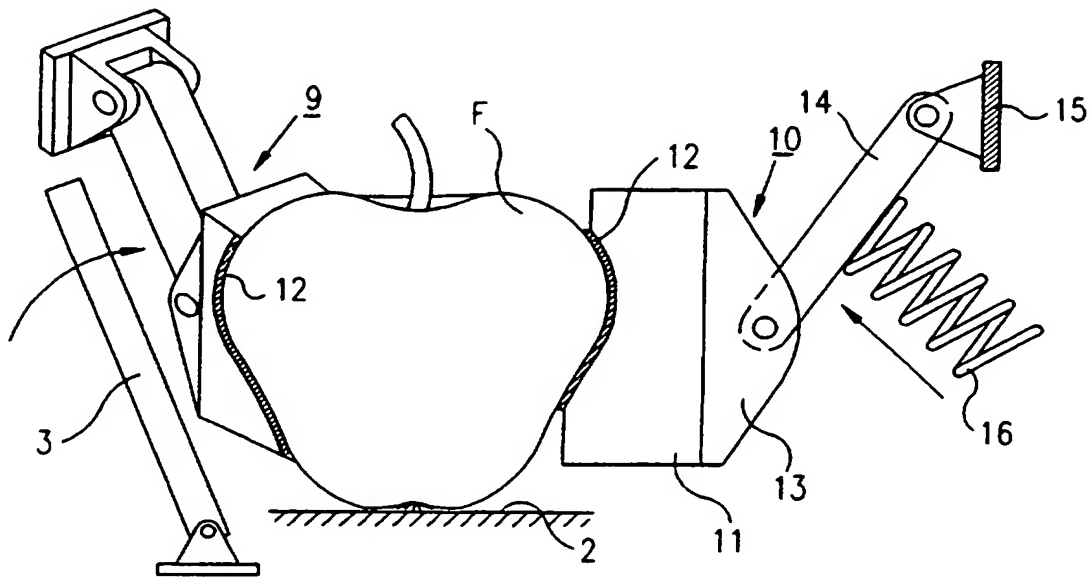


FIG. 4

FIG. 5

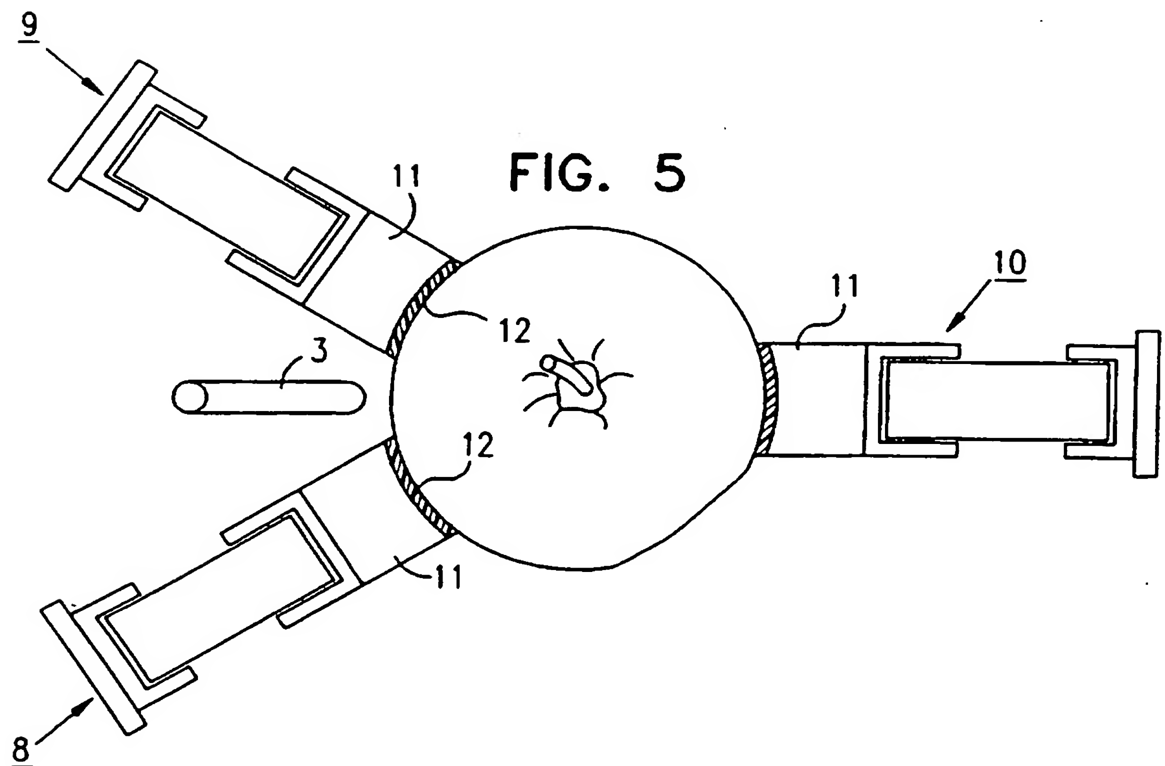


FIG. 6

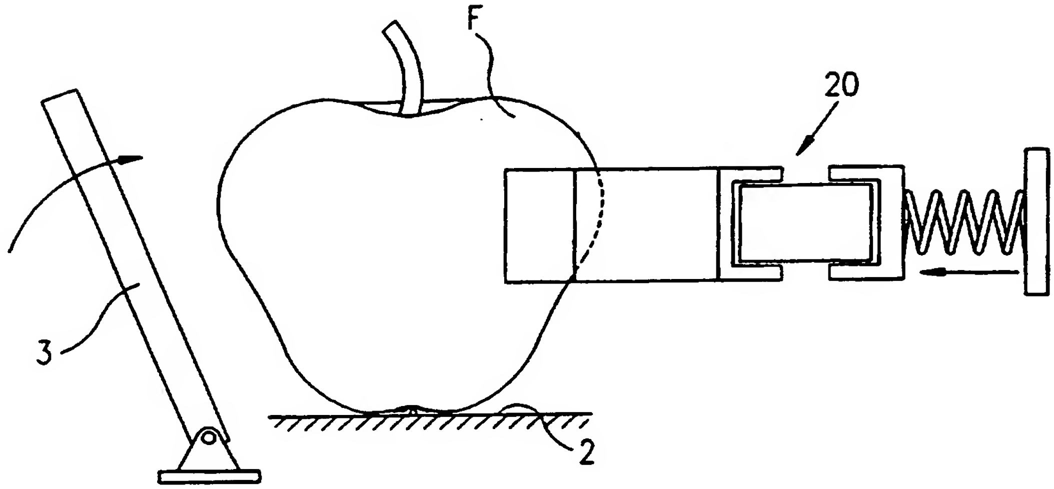


FIG. 7

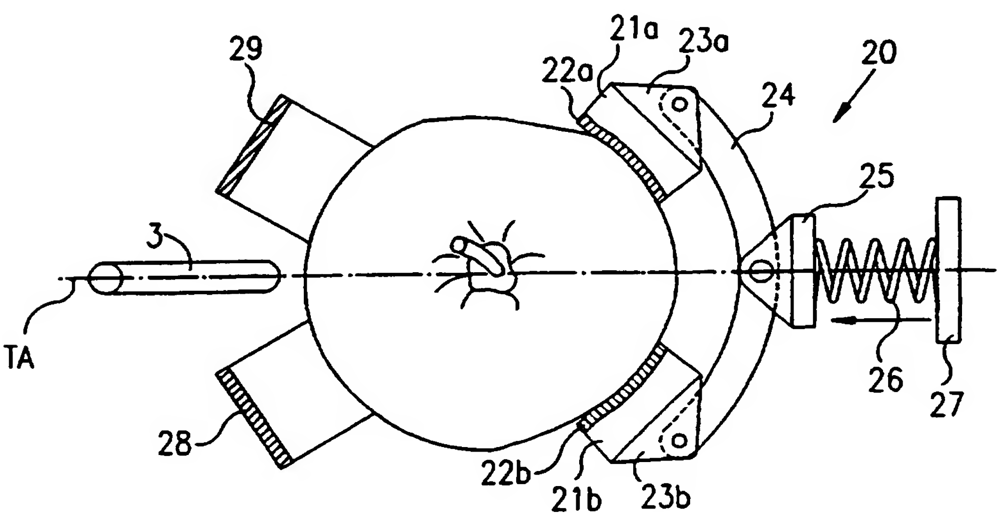


FIG. 8

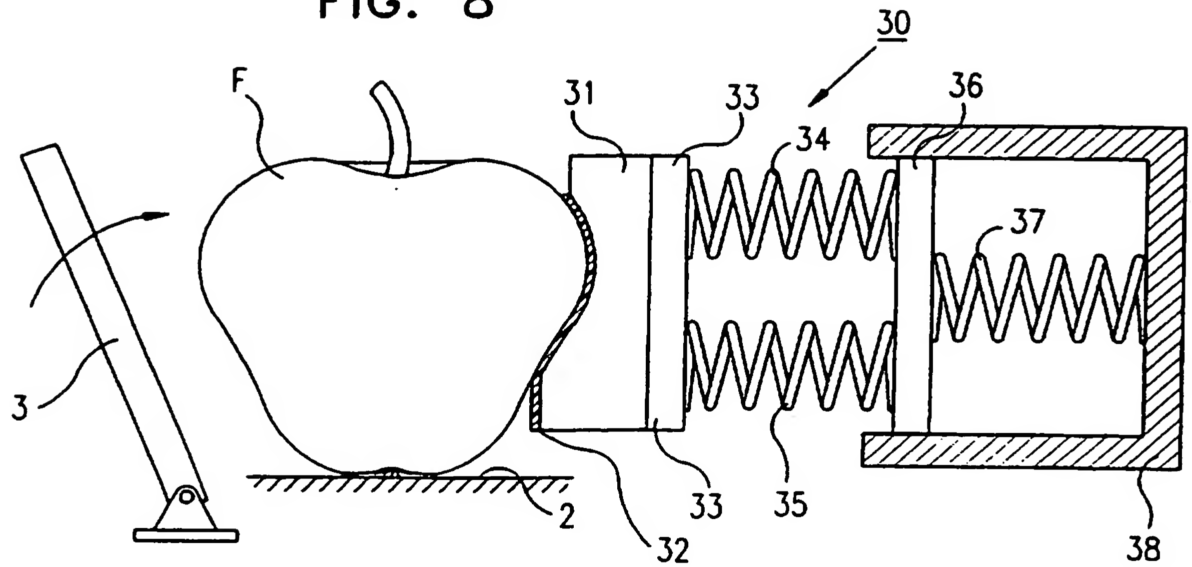

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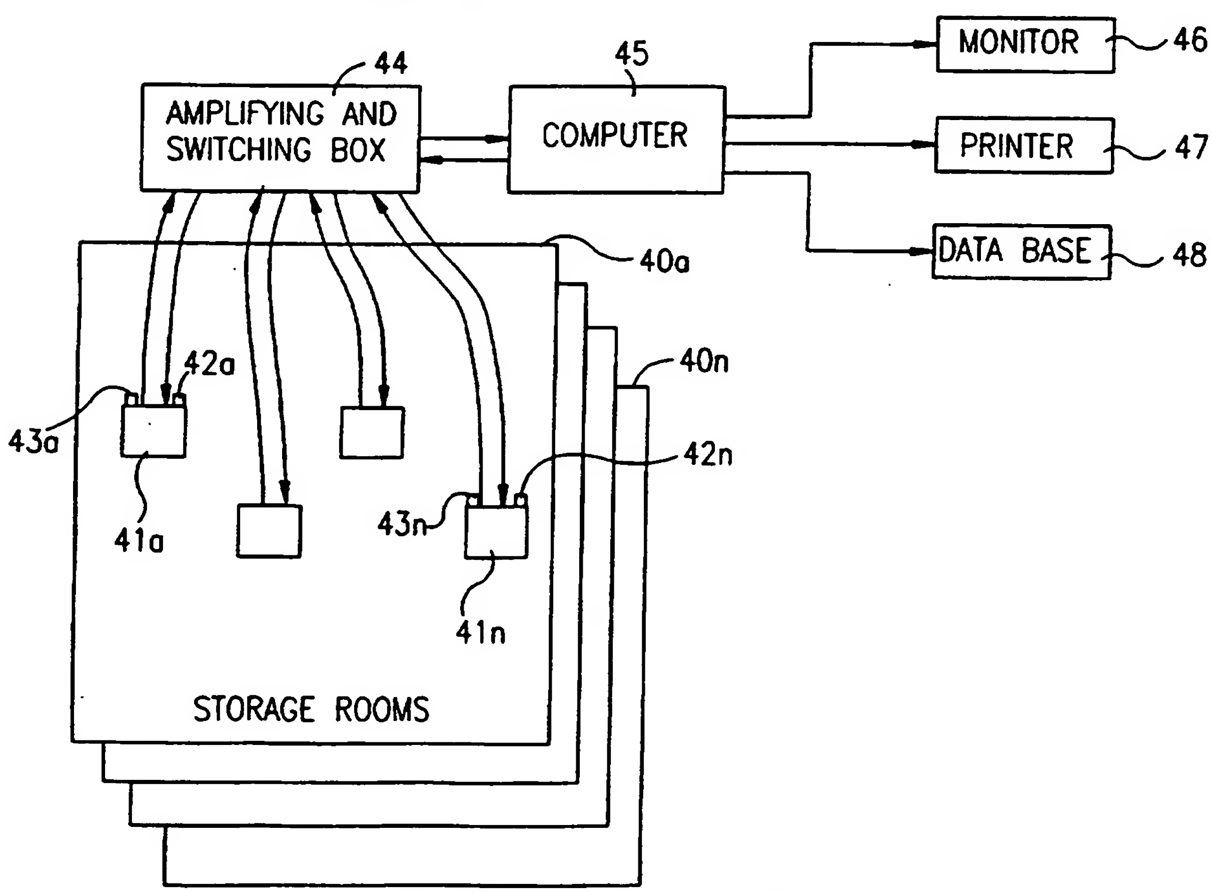
FIG. 9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MONITOR
46
PRINTER
47
DATA BASE
48
40a
40n
42a
43a
41a
42n
43n
41n
STORAGE ROOMS

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL97/00021

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B07C 5/34, 5/08, 9/00; G01H 1/00, 9/00, 13/00
US CL : 209/599, 604, 699; 73/579
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 209/599, 604, 699; 73/579
209/599,600,601,604,699,571; 73/579

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,152,401 A (H. A. Affeldt, Jr. et al) 06 October 1992 See the entire document	None
A	US 2,277,037 A (H. L. Clark et al) 24 March 1942 See the entire document	None
A	US 4,884,696 A (K. Peleg) 05 December 1989 See the entire document	None

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
06 MAY 1997

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05 JUN 1997

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